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Separate Organic and Inorganic Baggage Using Dual Energy X-ray Inspection System

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1. Introduction

An acquired image in the existing X-ray inspection system show brightness images as penetration capacity of material by X-ray without regard to composition of materials. At present, the explosive and narcotic materials which great concern at domestic and foreign have a high organic content in comparison with general materials, because they are mainly composed of organic material(O,C,N). This system is specially designed to meet the requirements which high security and total screening of objects against illegal possession of the explosive and narcotic materials at a port, airport by inspection for distribution of organic and inorganic material in the cargo and baggage for passengers.

2. Methods and Results

In this section some of the techniques used separate organic and inorganic baggage using dual energy X-ray inspection system.

2.1 Dual Energy Detector

X-ray detector designed to absorb maximum energy form radiation source. The signal transmitted through the screened object is detected first by the low energy detector and subsequently by high energy detector. A thin sheet of copper placed in between the low energy and high energy detector and that is acts as a filter by absorbing the low energy X-rays and letting the high energy X-rays go through.

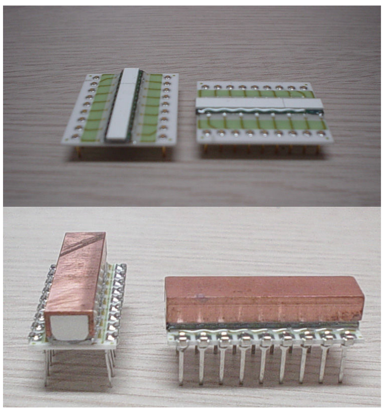

Figure 1. Low and High energy Detector layout

2.2 Data Acquisition System

DAS(Data Acquisition System) consist of HED(High Energy Detector) and LED(Low Energy Detector), Dual Integrator, ADC, FPGA for control. Each board has 64 channels. 32 boards can be connected in parallel to provide a detector with up to 2048 channels. The data Acquisition board provides one serial bit stream output. That is make to image dividing by high and low energy data in computer.

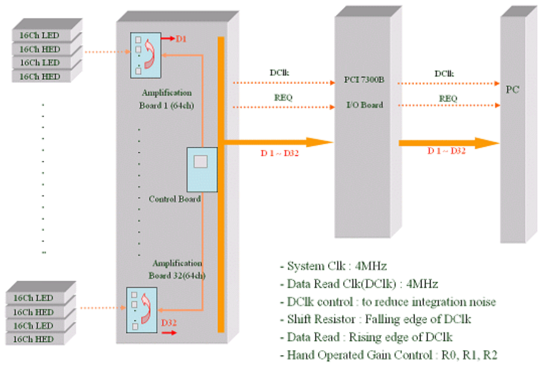

Figure 2. Data Acquisition System Block diagram.

2.3 Image Processing algorithm

X-ray attenuation factor was determinate that material's own characteristic and density, incidence X-ray energy. Divided organic, intermediate material, inorganic boundary from acquired Z-map through effective atomic number 20 from 10 material variant thickness for separate organic and inorganic baggage.

$$T_\varsigma(L) = -\ln\frac{I(L)}{I_0(L)} = \mu_\varsigma(L)t_\varsigma$$

$$T_\varsigma(H) = -\ln\frac{I(H)}{I_0(H)} = \mu_\varsigma(H)t_\varsigma$$

This two ratio R is constant value that have nothing to relation of thickness.

$$R_\varsigma = \frac{T_\varsigma(H)}{T_\varsigma(L)} = \frac{\mu_\varsigma(H)}{\mu_\varsigma(L)}$$

After Low and high energy Image correction, calculate T_{Low} and T_{High} value using each Image pixel value that organic material and intermediate material boundary equation is blow expression.

$$T_{High} = 0.65\,T_{Low} + 0.080\,T_{Low}^2 \qquad (T_{Low} < 1.8)$$

$$T_{High} = 0.09 + 0.63\,T_{Low} + 0.078\,T_{Low}^2 + 0.0095\,T_{Low}^3 \quad (1.8 \leqq T_{Low} < 4.1$$

$$T_{High} = 0.49\,T_{Low} + 0.080\,T_{Low}^2 \qquad (4.1 \leqq T_{Low})$$

On equal terms, intermediate material and metal material's boundary equation is blow expression.

$$T_{High} = 0.49\, T_{Low} + 0.080\, T_{Low}^2 \qquad (\, T_{Low} < 3.5\,)$$
$$T_{High} = -\, 0.07 + 0.63\, T_{Low} + 0.078\, T_{Low}^2 + 0.0095\, T_{Low}^3\, (3.5 \leqq \, T_{Low}\,)$$

Besides, For reduce exterior influence, a new scatter correction method in dual energy X-ray inspection system was suggested. The correction method is based on iterative thickness estimation using unique scatter point spread functions, so it is named TB scatter correction method.[1]

2.4 Image Result

Some organic material and high Z instrument's acquisition Image using image processing algorithm.

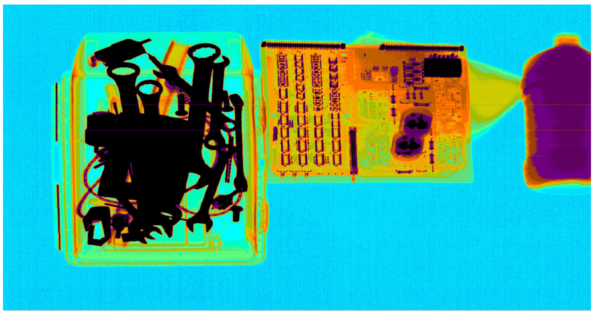

Figure 3. Dual Energy Image

3. Conclusion

It's very difficult situation what we extract this transmitted data which was mixed with character of objects when so many objects get accumulated for targets of searching. To change for the better, we make a database through continuing experiments and we are trying to make a better attaching X-ray generator of another energy bauds. We hope that dual energy X-ray inspection system can be used more detail separate industrial applications.

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